README Document for

NASA Energy and Water cycle Study (NEWS) Climatology of the 1st decade of the 21st Century Dataset

Prepared by

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Revision History

Revision Date	***Changes***	***Author***
09/16/2015	Initial version based on information from Hiroko Beaudoing	Hualan Rui
10/08/2015	Reviewed and revised	Hiroko Beaudoing
11/30/2015	Updated the references	Hualan Rui

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Introduction

This dataset summarizes the original observationally-based mean fluxes of Water and Energy Budget (WEB) components during the first decade of the 21st Century, for each continent and ocean basin on monthly and annual scales as well as means over all oceans, all continents, and the globe. A careful accounting of uncertainty in the estimates is included. Also, it includes optimized versions of all component fluxes that simultaneously satisfy energy and water cycle balance constraints. This dataset is a product of the companion papers: Rodell et al. 2015 and L'Ecuyer et al. 2015.

Basic characteristics of the NEWS WEB Climatology data

Table 1. Basic characteristics of the NEWS WEB Climatology data.

Contents	Water and Energy Budget
Input data	Observationally-based fluxes and states
Spatial Coverage	Global
Spatial resolution	Continents and ocean basins
Temporal resolution	Annual climatology Monthly climatology
Temporal coverage	1st decade of the 21st Century
Format	xlsx, csv, NetCDF
Missing value	-999.00

Updates

Please periodically check the GES DISC web site and GES DISC Hydrology Portal for the latest release.

Acknowledgment

NASA requests that you include the following acknowledgment in papers published using these data:

"*The data used in this study were acquired as part of the mission of NASA's Earth Science Division and archived and distributed by the Goddard Earth Sciences (GES) Data and Information Services Center (DISC).*"

We would appreciate receiving a copy of your publication, which can be forwarded to the following address:

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Data Organization

The data are organized in two data products, annual climatology and monthly climatology, and named as:

NEWS_WEB_ACLIM.1.0
NEWS_WEB_MCLIM.1.0

Where "ACLIM" denotes annual climatology and "MCLIM" indicates monthly climatology.

The data are presented in four different units, namely; mm/day, W/m^2, cm/year (or cm/month), and 1000km^3/year (or 1000km^3/month), and archived in three different formats, NetCDF(.nc4), Excel (.xlsx), comma delineated text (.cvs). The file names are listed in the Table 2.

Table 2. File names for NEWS WEB Climatology data

Format	Annual Climatology File Name	Monthly Climatology File Name	Unit
Excel	NEWS_WEB_ACLIM.1.0.xlsx	NEWS_WEB_MCLIM.1.0.xlsx	*
csv	NEWS_WEB_ACLIM.1.0_Wm-2.csv	NEWS_WEB_MCLIM.1.0_Wm-2.csv	W/m^2
csv	NEWS_WEB_ACLIM.1.0_1000km3yr-1.csv	NEWS_WEB_MCLIM.1.0_1000km3mon-1.csv	1000km^3/yr or 1000km^3/mon
csv	NEWS_WEB_ACLIM.1.0_cmyr-1.csv	NEWS_WEB_MCLIM.1.0_cmmon-1.csv	cm/year or cm/mon
csv	NEWS_WEB_ACLIM.1.0_mmday-1.csv	NEWS_WEB_MCLIM.1.0_mmday-1.csv	mm/day
nc4	NEWS_WEB_ACLIM.1.0.nc4	NEWS_WEB_MCLIM.1.0.nc4	**
nc4	NEWS_WEB_REGIONMAP.nc4	NEWS_WEB_REGIONMAP.nc4	***

* Excel file includes the flux data in all four units, along with the area.

** NetCDF file includes the flux data in all four units, along with names and areas of continents, ocean basins, World Land, World Ocean, and World. Variables are named following the convention:

Varname_STATUS_UNITSNAME

where STATUS is "obs" for observed or "opt" for optimized; UNITSNAME are "volume", "height", "rate", or "flux" for 1000km^3/year (or 1000km^3/month), cm/year (or cm/month), mm/day, and W/m^2, respectively.

*** The data for the map of continents/ocean basins delineation used in the study (Figure 1) is provided in NetCDF format.

Data Contents

The data set contains the original observationally-based mean fluxes of water and energy budget components during the first decade of the 21st Century, for each continent and ocean basin on monthly and annual scales as well as means over all oceans, all continents, and the globe. A careful accounting of uncertainty in the estimates is included. Also, it includes optimized versions of all component fluxes that simultaneously satisfy energy and water cycle balance constraints.

The observationally-based mean fluxes and stores are predominantly satellite based measurements. The model outputs included in the analysis have been constrained by in-situ or remote sensing observations. The sources of data are listed in Table 2 of Rodell et al for water budget and Table 1 of L'Eculyer et al for energy budget components, respectively.

The climatology base period is roughly 1998-2010 where individual dataset covers various periods starting as early as 1998 and as late as 2002, not all extending to 2010.

The continents and Ocean basins boundaries map (Figure 1) is used in this study to compute regional means. The Ocean basin data was provided by Kyle Hilburn and Chelle Gentemann at Remote Sensing Systems. The land portion and some inland water bodies of the data are delineated into continents. The boundaries are defined to be comprehensive global coverage and relevant to past studies. The Table 3 lists the continents and ocean basins, along with the corresponding area in square kilometer. World Land consists of the sum of all continents. Similarly, World Ocean is the sum of all basins. World is the total area.

Figure 1. Continents and Ocean Basins for NEW WEB climatology data

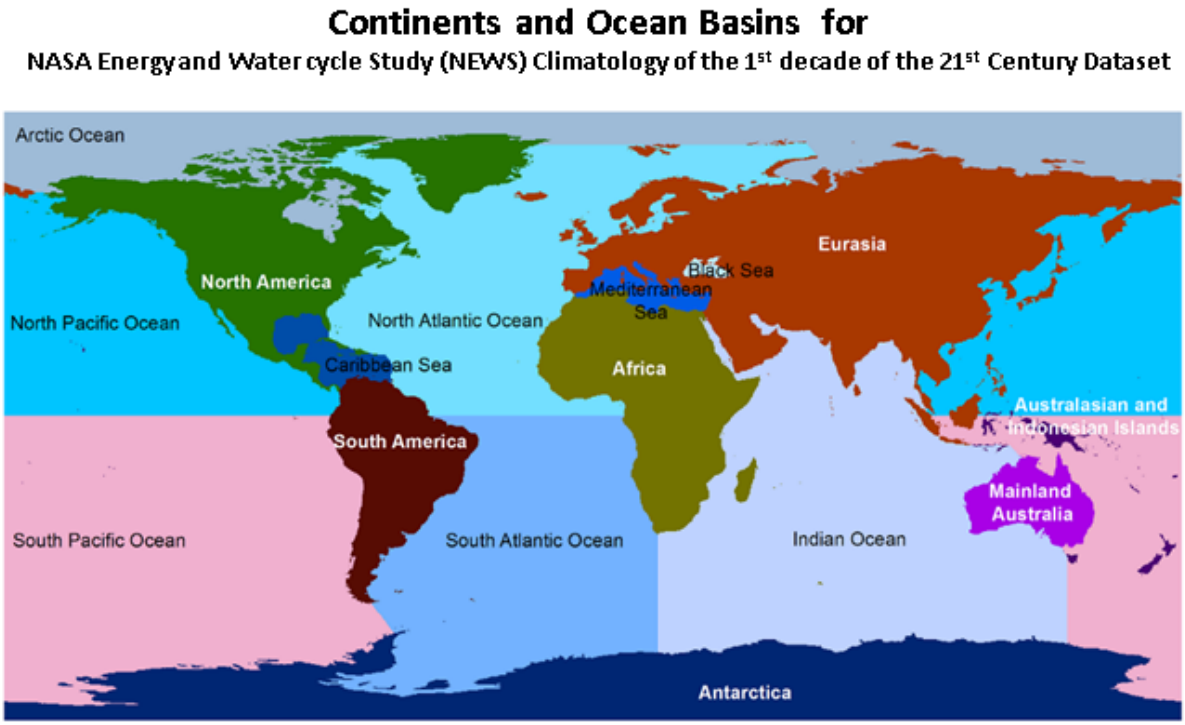

Table 3. Continents and Ocean Basins for NEWS WEB Climatology Data

Region	**Area (KM^2)**
North America	24030089
South America	17737690
Eurasia	53234055
Africa	29903956

Mainland Australia	7560766
Australasian and Indonesian Islands	1484627
Antarctica	12705364
World Land	146656546
Arctic	10153134
North Pacific	81774276
South Pacific	99933892
North Atlantic	43384135
South Atlantic	46513141
Indian	75370126
Caribbean Sea	4345760
Mediterranean Sea	2604532
Black Sea	472006
World Ocean	364551002
World	511207548

The information of Table 3 are included in the NEW WEB annual and monthly climatology NetCDF files, as variable arrays "region_name" and "area".

Annual Climatology Data (NEWS_WEB_ACLIM.1.0)

The data product contains 18 variables (Table 4), consisting of 14 flux components, 2 budget terms, and 2 residuals. Each flux variable contains values for mean and uncertainty. All variables contain observed and optimized estimates per region.

Table 4. Variables in NEWS WEB Annual Climatology Data

No.	**Short Name (key)**	**Description**
1	P	precipitation (atmospheric latent heat)
2	ET/E	evapotranspiration or ocean evaporation (surface latent heat)
3	Q	total runoff
4	Q_RUN	surface runoff portion of Q
5	Q_SDG	submarine discharge portion of Q
6	C	net atmospheric convergence
7	DLR	downwelling longwave radiation at surface
8	DSR	downwelling shortwave radiation at surface
9	ULW	upwelling longwave radiation emitted by the surface
10	USW	upwelling shortwave radiation reflected by the surface
11	SH	sensible heat flux
12	OSR	outgoing shortwave radiation at top of atmosphere
13	OLR	outgoing longwave radiation at top of atmosphere
14	F	incoming solar radiation at top of atmosphere
15	SWB	surface water budget residual

16	AWB	atmospheric water budget residual
17	NET	surface energy budget
18	NETA	atmospheric energy budget
	error	uncertainty of associated flux

Note:

1. "Residual" indicates imbalance in surface and atmospheric water budget where dS and dW are zero at annual scale. They are computed as follows:
   SWB = P – ET – Q – dS (Land) SWB = P – E + Q -dS (Ocean)
   AWB = P - ET – C + dW (Land and Ocean)
2. Energy budget equations for Land and Ocean:
   NET = DLR + DSR – ULW – USW – E – SH
   NETA = F – OSR –OLR + P + SH – DLR – DSR + ULW + USW
3. OSR, OLR, and F are used to constrain NETA at global scale only (World).
4. NET is computed at continents, World Land, World Ocean, and World (no individual basins).
5. Surface runoff and submarine discharge estimates are available only for "observed" because they are not distinguished in the optimization.

Monthly Climatology Data (NEWS_WEB_MCLIM.1.0)

The data product contains 16 variables (Table 5), consisting of 14 flux and storage/budget variables and 2 residuals. Each of these flux and storage/budget variables has mean and uncertainty. All variables contain observed and optimized monthly estimates per region,

Table 5. Variables in NEWS WEB Monthly Climatology Data

	Short Name (key)	**Description**
1	P	precipitation (atmospheric latent heat)
2	ET/E	evapotranspiration or ocean evaporation (surface latent heat)
3	Q	total runoff
4	Q_RUN	surface runoff portion of Q
5	Q_SDG	submarine discharge portion of Q
6	C	net atmospheric convergence
7	dS	change in surface water storage
8	dW	change in precipitable water in the atmospheric column
9	DLR	downwelling longwave radiation at surface
10	DSR	downwelling shortwave radiation at surface
11	ULW	upwelling longwave radiation emitted by the surface
12	USW	upwelling shortwave radiation reflected by the surface
13	SH	sensible heat flux
14	SWB	surface water budget residual
15	AWB	atmospheric water budget residual
16	NET	surface energy budget
	error	uncertainty of associated flux

Note:

1. "Residual" indicates imbalance in surface and atmospheric water budget and they are computed as follows:
   SWB = P – ET – Q – dS (Land) SWB = P – E + Q -dS (Ocean)
   AWB = P - ET – C + dW (Land and Ocean)
2. Energy budget equation:
   NET = DLR + DSR – ULW – USW – ET – SH (Land)
   NET = DLR + DSR – ULW – USW – E – SH (Ocean)

Region Map Data (NEWS_WEB_REGIONMAP)

The map data contains indexes ranging from 1 to 19 (Table 6). The indexes are mapped into the NEWS Region (right column) to arrive at the regions used in this study (Figure 1).

Table *6 NEWS WEB REGIONMAP Data*

Value	Key	NEWS Region
1	Arctic	Arctic
2	Caribbean Sea	Caribbean Sea
3	Mediterranean Sea	Mediterranean Sea
4	Black Sea	Black Sea
5	Caspian Sea	Eurasia
6	Great Lakes	North America
7	North Pacific	North Pacific
8	North Atlantic	North Atlantic
9	Indian	Indian
10	South Pacific	South Pacific
11	South Atlantic	South Atlantic
12	Antarctica	Antarctica
13	South America	South America
14	North America	North America
15	Africa	Africa
16	Eurasia	Eurasia
17	Mainland Australia	Mainland Australia
18	Australasian and Indonesian Islands	Australasian and Indonesian Islands
19	Greenland	North America

Reading the Data

The NEWS WEB Climatology Data are archived in xlsx, csv, and NetCDF formats.

The xlsx and csv files can be opened by Excel.

NetCDF is a self-describing and machine-independent NetCDF format. A Unidata page, http://www.unidata.ucar.edu/software/netcdf/software.html, provides a list of software for manipulating or displaying NetCDF Data.

Reading/viewing the data by Panoply

Panoply, http://www.giss.nasa.gov/tools/panoply/, is a cross-platform application that plots geo-referenced and other arrays from NetCDF, HDF, GRIB, and other data sets.

The Data Cookbook of NASA GES DISC provides a recipe for Quick View Data with Panoply.

Data Access

The NASA GES DISC maintains archives of the NEWS WEB Climatology Data and many other Hydrology data sets. The archived data can be accessed via HTTP network transfer. The data can be accessed via the GES DISC Unified User Interface (UUI) at http://disc.sci.gsfc.nasa.gov/uui/#/search/NEWS.

Data Volume

Since the data are climatology data, total data volume is less than 10 MB, including 0.3 MB for annual mean data and 1.2 MB for monthly mean data, and 4.1 MB for the Region Map data.

Search and download data via Mirador

The NEWS WEB Climatology Data can be searched through a keyword (e.g., NEWS) and downloaded via Mirador, http://mirador.gsfc.nasa.gov/.

HTTP Access

The NEWS WEB Climatology Data can be downloaded directly via the GES DISC HTTP server: http://hydro1.gsfc.nasa.gov/data/s4pa/NEWS/.

Points of Contact

For information about or assistance in using any GES DISC data, please contact the GES DISC Help Desk at:

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DOI

A Digital Object Identifier or DOI is a unique alphanumeric string used to identify a digital object and provide a permanent link online. DOIs are often used in online publications in citations. The table 3 list DOI for the NEWS WEB Climatology Data Version 1.0 data product.

Table 6. DOI for NEWS WEB Climatology Data Products

Short Name	Product Description	DOI
NEWS_WEB_ACLIM.10	NASA Energy and Water cycle Study (NEWS) Annual Climatology of the 1st decade of the 21st Century	In progress ……
NEWS_WEB_MCLIM.10	NASA Energy and Water cycle Study (NEWS) Monthly Climatology of the 1st decade of the 21st Century	In progress …….

The DOI in the Table 6 will be linked to the corresponding data product page and Data Citation for the data product is on top of the page. If you use the data in your research or applications please include a reference in your publication(s) similar to the following example:

Matthew Rodell, Tristan L'Ecuyer, and Hiroko Kato Beaudoing, NASA/GSFC/HSL (10.01.2015), NASA Energy and Water cycle Study (NEWS) Monthly Climatology of the 1st decade of the 21st Century *Version 1.0*, Greenbelt, Maryland, USA: Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed **Enter User Data Access Date** at doi:10.5067/XXXXXXXX.

References

Rodell, M., H. Beaudoing, T. L'Ecuyer, W. Olson, J. Famiglietti, P. Houser, R. Adler, M. Bosilovich, C. Clayson, D. Chambers, E. Clark, E. Fetzer, X. Gao, G. Gu, K. Hilburn, G. Huffman, D. Lettenmaier, W. Liu, F. Robertson, C. Schlosser, J. Sheffield, and E. Wood, 2015: The Observed State of the Water Cycle in the Early 21st Century. J. Climate, 28(21), 8289-8318, doi:10.1175/JCLI-D-14-00555.1.

L'Ecuyer, T., H. Beaudoing, M. Rodell, W. Olson, B. Lin, S. Kato, C. Clayson, E. Wood, J. Sheffield, R. Adler, G. Huffman, M. Bosilovich, G. Gu, F. Roberston, P. Houser, D. Chambers, J. Famiglietti, E. Fetzer, W. Liu, X. Gao, C. Schlosser, E. Clark, D. Lettenmaier, and K. Hilburn, 2015: The Observed State of the Energy Budget in the Early 21st Century. J. Climate, 28(21), 8319-8346, doi:10.1175/JCLI-D-14-00556.1.

Appendices

A. Acronyms

The following acronyms and abbreviations are used in this document.

DOI	Digital Object Identifier
GES DISC	Goddard Earth Sciences Data and Information Services Center
HDF	Hierarchical Data Format
HDISC	Hydrology Data and Information Services Center
HSL	Hydrological Sciences Laboratory
Mirador	Fast interface for searching Earth science data at NASA GES DISC
NEWS	NASA Energy and Water cycle Study
NASA	National Aeronautics and Space Administration
NetCDF	Network Common Data Form
WEB	Water and Energy Budget